

# Permeable Reactive Barriers for Reduction of Nitrate Discharge from Septic Systems – Great Bay Pilot Project

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*In association with*

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**Vicky Stafford, Assistant District Manager**  
Rockingham County Conservation District

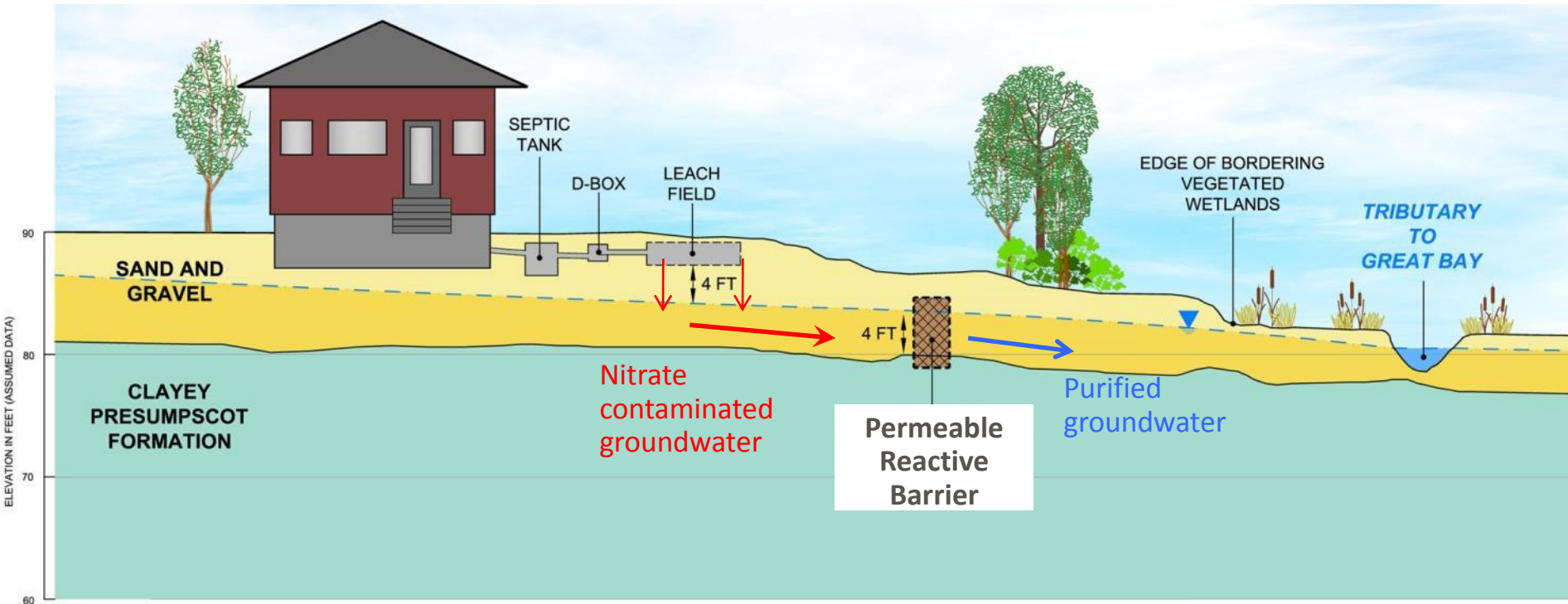


# Project Purpose

- To install pilot systems and test effectiveness of Permeable Reactive Barriers (PRBs) in the Great Bay Watershed for nitrogen removal
- To gather shallow groundwater quality data adjacent to existing septic systems to determine septic system nitrate contribution to groundwater
- **To implement effective nitrogen removal solutions in the Great Bay Watershed as part of the watershed management plan.**



# Permeable Reactive Barrier (PRB) Demonstration: Showing Nitrate Removal Using PRB



SITE DESIGNATION	LENGTH OF NITREX™ PRB	DEPTH OF NITREX™ PRB
RESIDENTIAL SYSTEM (600 GPD ±) DURHAM, NH	50 FT	5 FT
COMMUNITY SYSTEM (8,000 GPD ±) BRENTWOOD, NH	110 FT	8 FT

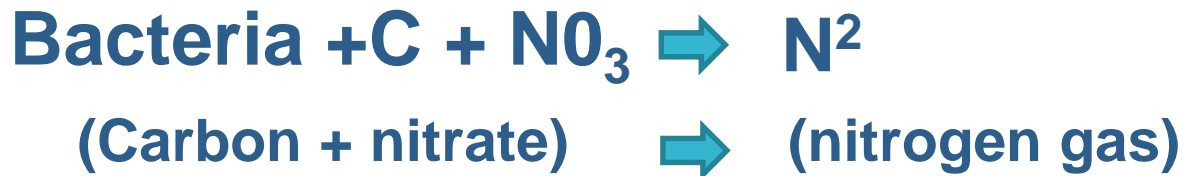
## NOTES:

1. ASSUME DEPTH IS 1 FT INTO CLAY AND 1 FT ABOVE TYPICAL GROUNDWATER DEPTH.
2. TYPICAL NITREX PRB WIDTH TO BE 6 FT.



# Wood Chip Bioreactor PRBs

- Low-cost carbon source for denitrification
- Shallow barriers are simple to install and maintain
- PRB creates the right chemical environment for the naturally occurring bacteria (anaerobic) to thrive
- Ammonia not treated by PRBs



1, 2 and 8-yr-old woodchips

(Dr. Will Robertson, U. Waterloo, Canada)

[wroberts@sciborg.uwaterloo.ca](mailto:wroberts@sciborg.uwaterloo.ca)

# PRB Design Parameters



- **Understanding of Site Hydrogeology:**  
How fast does groundwater flow, how permeable is subsurface material, what is the direction of groundwater flow, how do groundwater levels change, what is the concentration of nitrate in groundwater?
- **PRB Residence time:** (How long does groundwater stay in PRB for treatment?)  
Function of removal goal: Published values range from 0.7 to 32 mg/L of N per day over the area of the PRB.
- **Width and Depth of PRB:**  
Width is determined by estimated PRB residence time, and depth determined by site specific geology

# Conceptual Great Bay PRB Designs



- **Design Parameter:** 2 mg/L N/day Removal
- **Residence time of 10 to 20 days:**  
Groundwater travel time or groundwater velocity is about 0.1 ft/day at Durham and Brentwood Sites
- **Design Width of PRB** = 2.0 ft wide for a 10 to 20 days residence time
- **Depth:** Durham = 5 ft.  
Brentwood = 8 ft.
- **Length:** Durham = 50 ft.  
Brentwood = 110 ft.

# Durham Site

- Near Chesley Brook tributary of Oyster River
- Failed septic close to house, new septic field installed 2008
- Silty sand underlain by silt
- Initial nitrate 6.2 mg/L at one field-side monitoring well,
- Installation May 2016





# Groundwater Elevations (December 2014)



GREEN DOTS  
ARE  
MONITORING  
WELLS

## Legend

- Groundwater Elevation 0.5' Contours
- ~ Hydrography
- Septic System Leach Fields

Great Bay PRB Pilot Study

Rockingham County Conservation District  
Strafford County Conservation District  
Permeable Reactive Barrier Demonstration Project  
Durham, NH



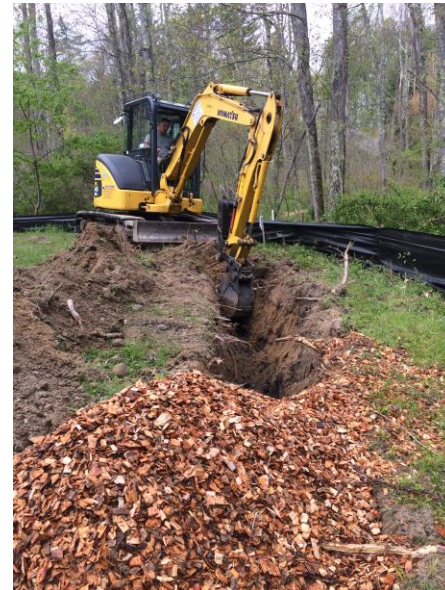


# Construction of Durham, NH PRB

## 19 May 2016



- Wetland protection for access,
- trench stayed open
- Less than 1 day to complete





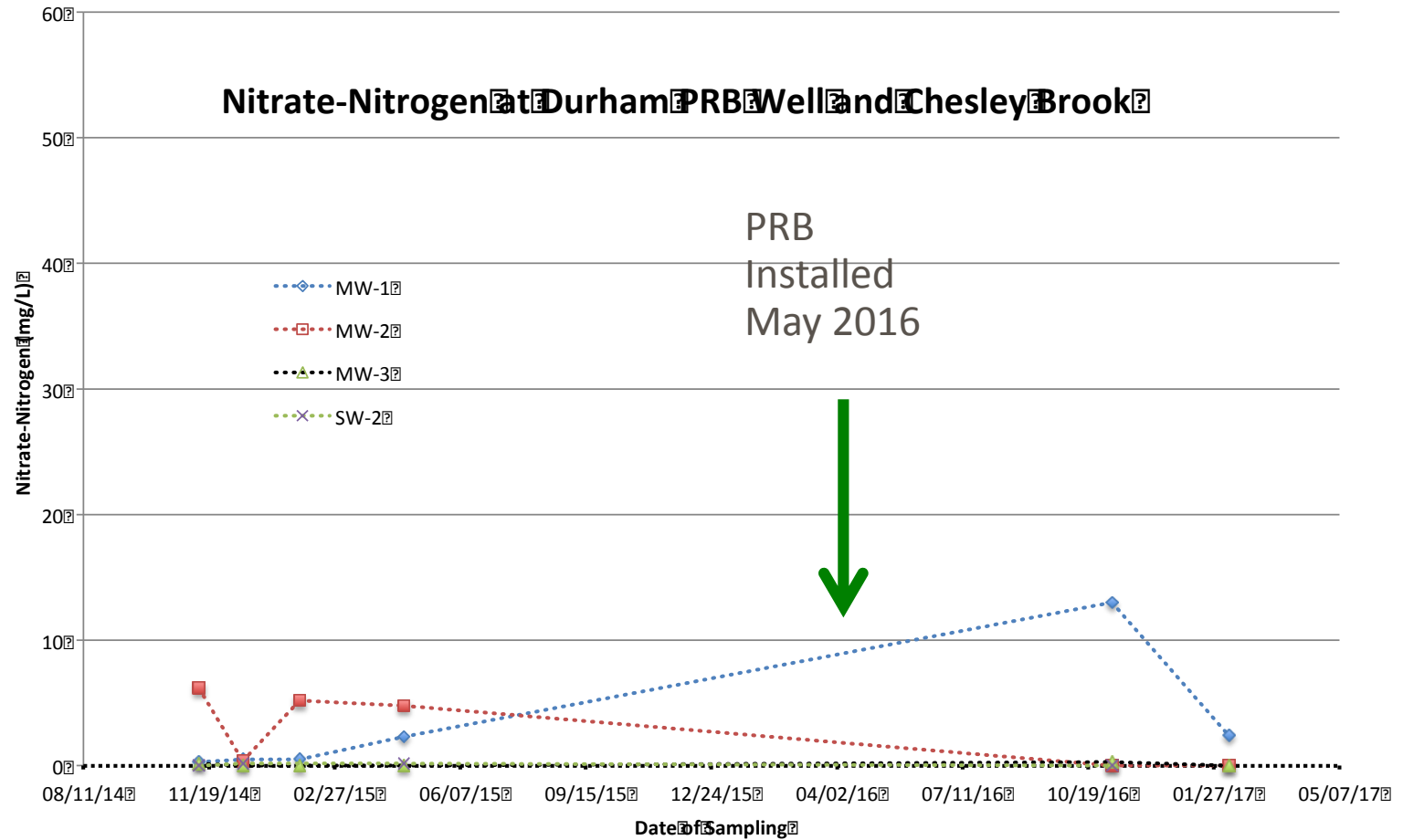
# Construction of Durham, NH PRB

## 19 May 2016



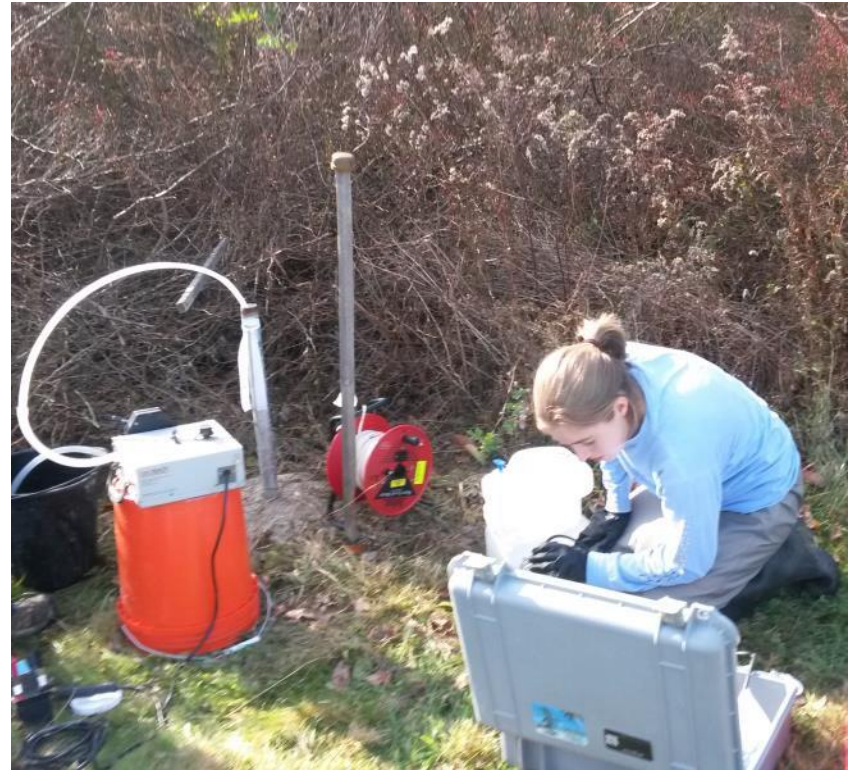
- Areas seeded
- Silt fence will stay up until full re-growth
- Additional well installation and monitoring through 2017

# Nitrate-Nitrogen at Durham PRB Well and Chesley Brook



# Brentwood Site

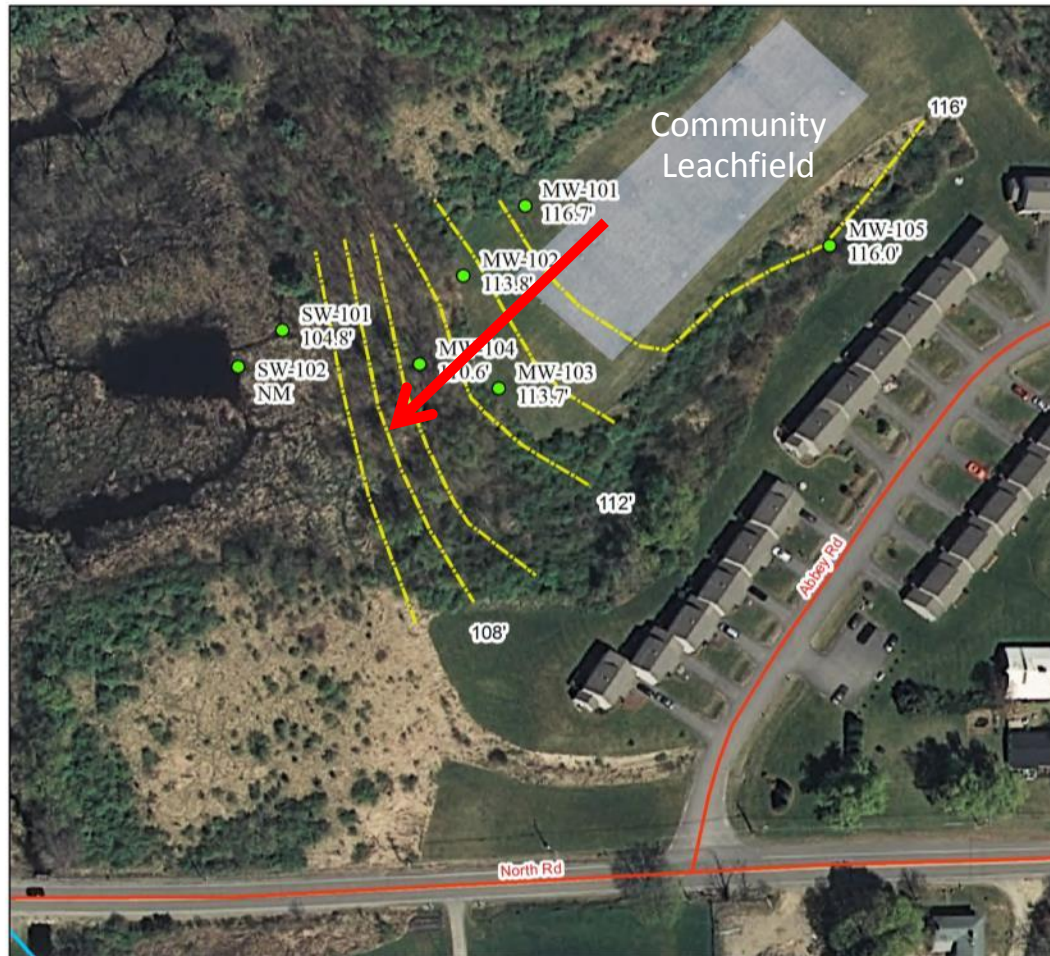
- Near Dudley Brook, tributary of Exeter River
- Failed septic area in community septic field
- New area installed in 2012
  - Silty sand with underlying silt
- Nitrate 12 to 46 mg/L at wells
- 1.9 mg/L in nearby SW measured in past
- Installed October 2015





## Groundwater Elevations (December 2014)

Pond  
flows to  
Dudley  
Brook



GREEN DOTS  
ARE  
MONITORING  
WELLS

### Legend

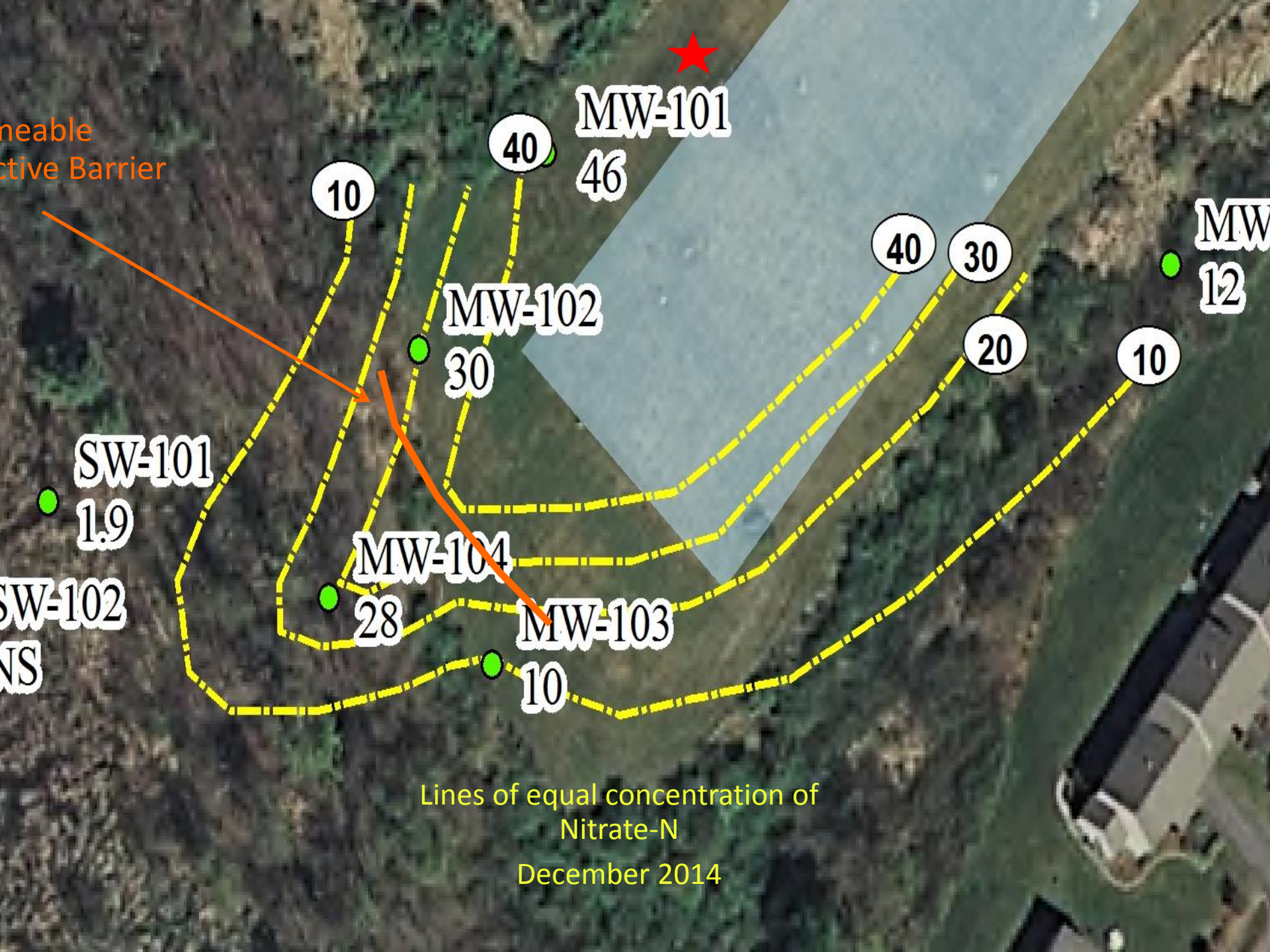
- Groundwater Elevation 2' Contours
- Hydrography
- Septic System Leach Fields
- Roads
- Monitoring Wells (MW)

Rockingham County Conservation District  
Strafford County Conservation District  
Permeable Reactive Barrier Demonstration Project  
Brentwood, NH





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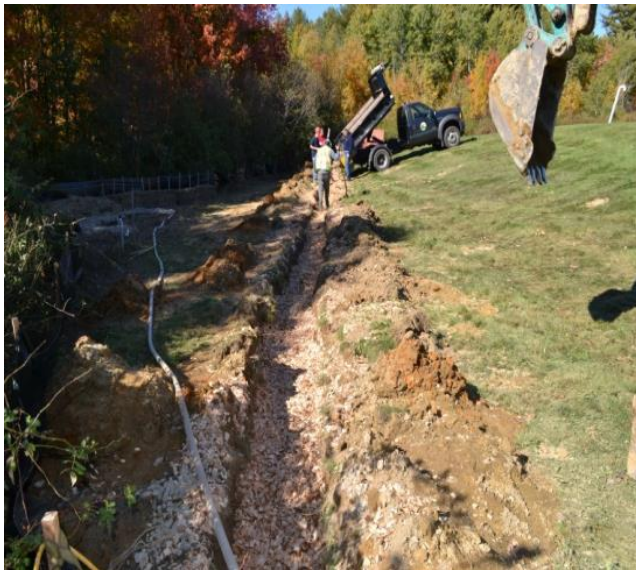
# Construction of Brentwood, NH

## PRB – 13 October 2015



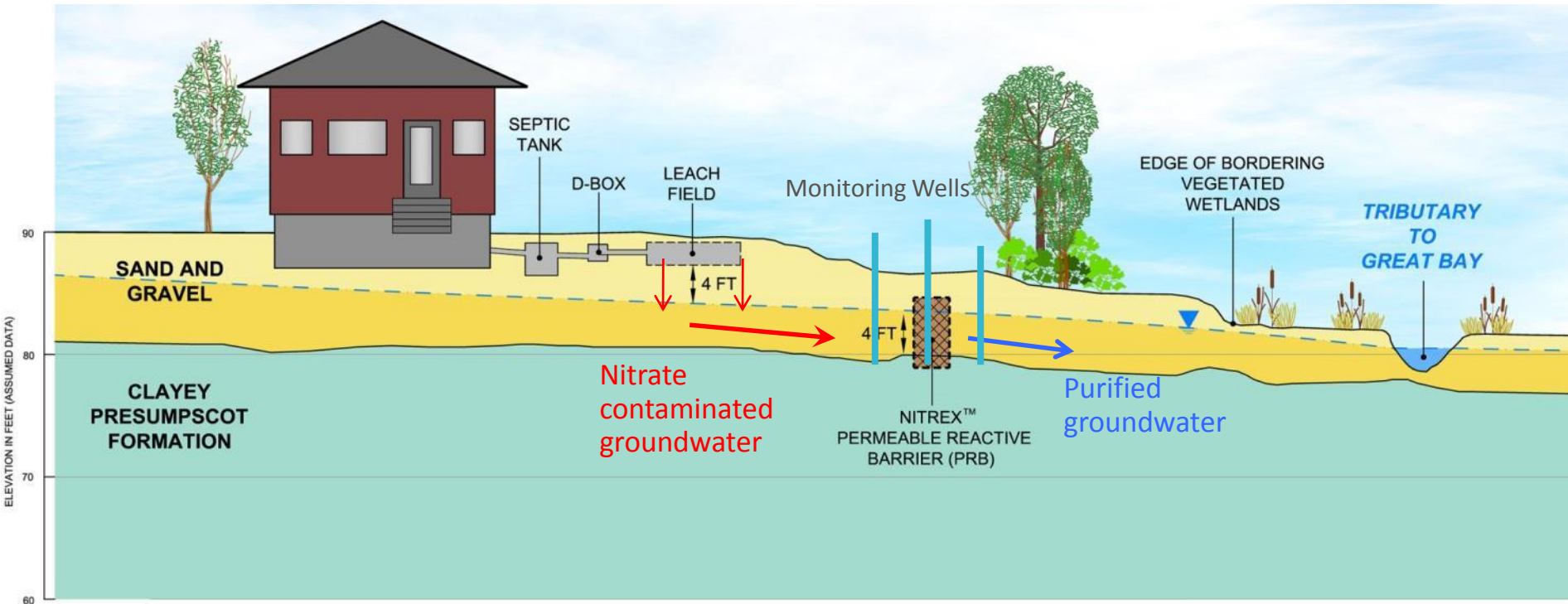


# PRB Placement and Site Restoration



Great Bay PRB Pilot Study

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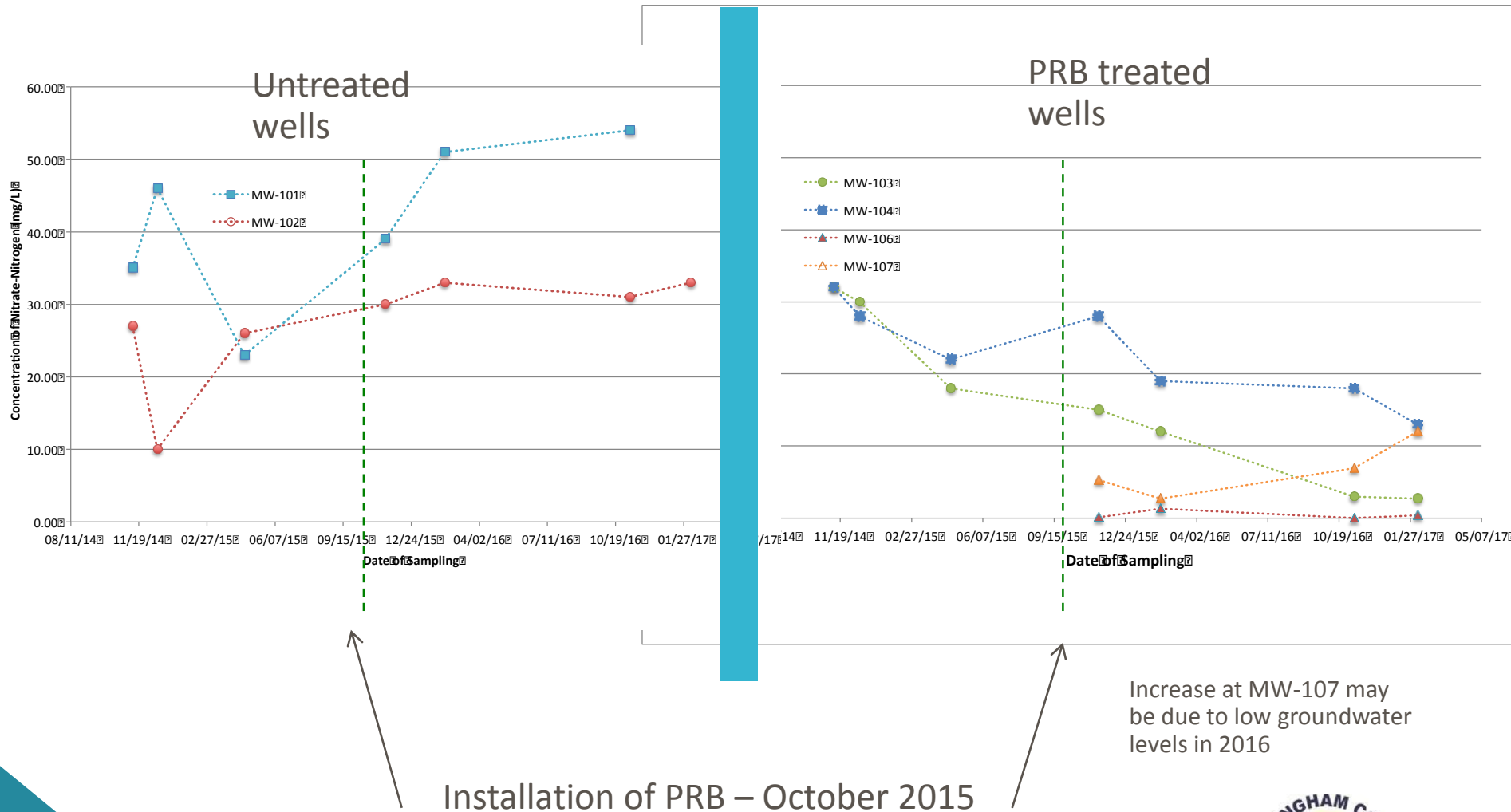
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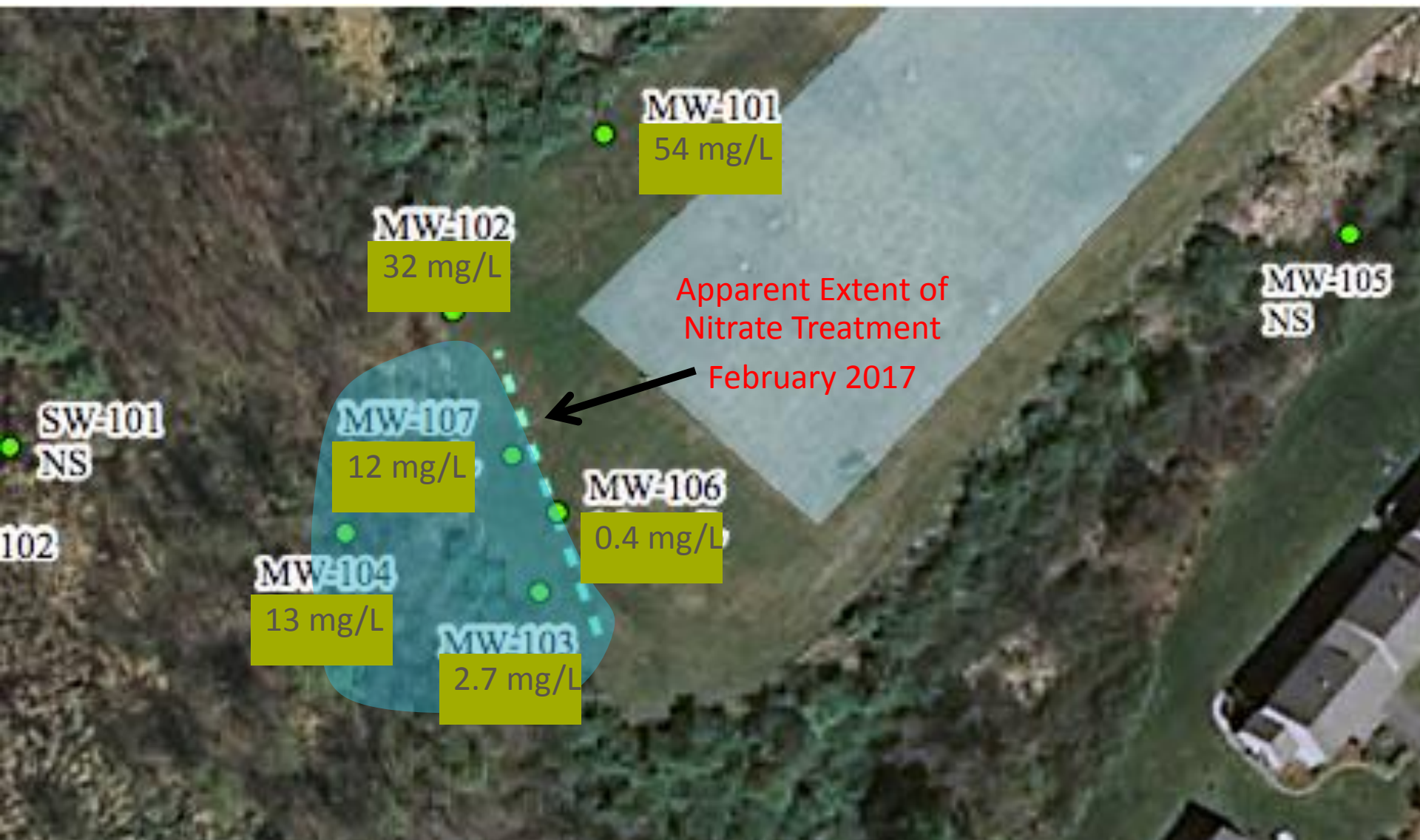


# Monitoring Results

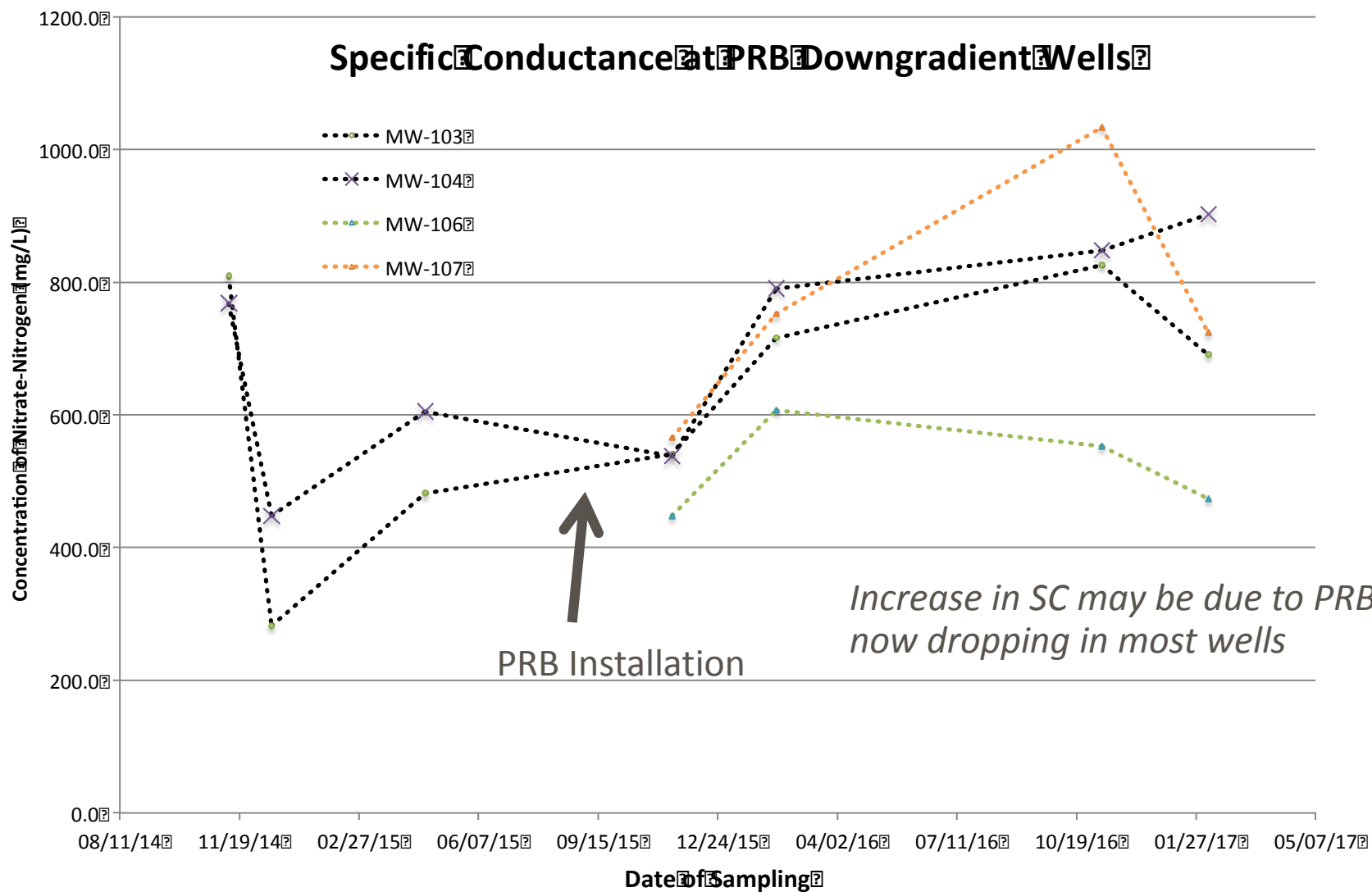
- New monitoring wells installed in and just downgradient of trench
- Nitrate-Nitrogen decline in and near trench
  - 20 to 30 mg/L pre installation
  - Less than 2 to 12 mg/l in and adjacent to trench – four months after installation
- Dissolved Oxygen (very low oxygen needed for bacterial growth)
  - 4 mg/L pre-installation to < 1.0 mg/L post installation at /near trench

# Change in Concentration of Nitrate at Brentwood PRB





Nitrate Concentrations in  
Wells February 2017



*Funding for this project was provided in part by a Watershed Assistance Grant from the NH Department of Environmental Services with Clean Water Act Section 319 funds from the US Environmental Protection Agency*

## Questions?





# Questions for practitioners

- How could you see this technology applied for your projects?
- How could this be used with a traditional septic system or as an added treatment tool?
- What obstacles/problems would you see in installing PRBs?